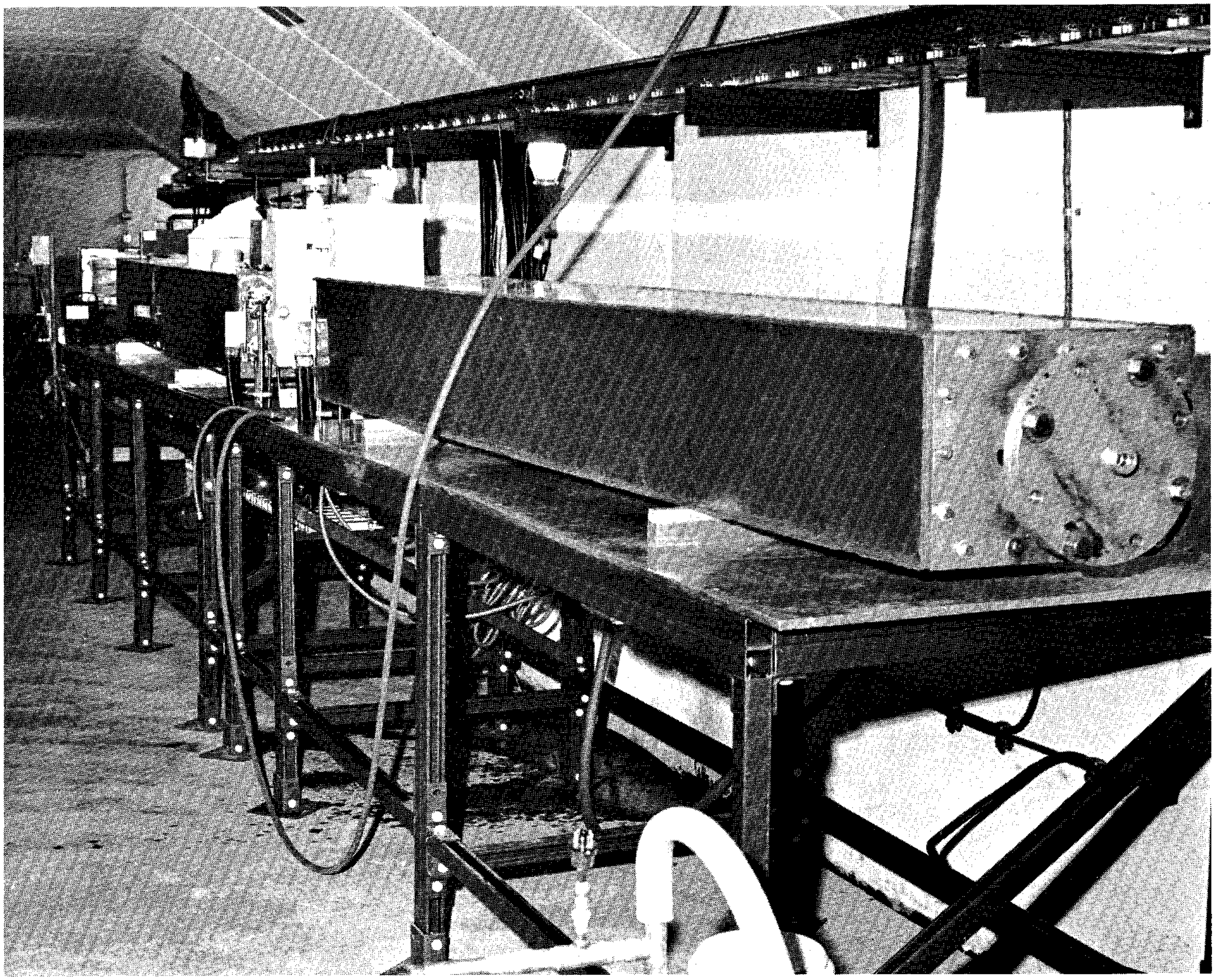
national accelerator laboratory

FERMILAB-NAL-028

MONTHLY REPORT OF ACTIVITIES

July 31, 1969



Operated by Universities Research Association Inc. Under Contract with the United States Atomic Energy Commission

The cover photograph shows booster magnet models mounted on temporary supports in the booster prototype enclosure.

MONTHLY REPORT OF ACTIVITIES

F. T. Cole

July 31, 1969

Abstract: This report covers the activities of the National Accelerator Laboratory in July, 1969.

General

1. Full Authorization. President Nixon signed the AEC authorization bill into law on July 11. This bill contains the full construction authorization of $250 million for the National Accelerator Laboratory.

2. Construction Funds. A total of $5.3 M of new funds was made available in July for construction. Most of this money was committed for linac technical components (see under "Linac" below). We have been informed that further amounts will be made available in August.

3. Construction Progress.

   a. Linac Building. The linac building is now over 50% complete. The structural work on the linac-cavity tunnel is almost completed and the crane rails in place, as can be seen in Fig. 1. The steelwork of the equipment gallery has been erected, as shown in Fig. 2, and work is in progress on the roof and walls. The linac building is scheduled to be finished December 27, 1969.

   b. Booster Enclosure. This building is 20% complete. Figure 3 shows a portion of the completed tunnel. More than one-fourth of the tunnel is completed and another fourth is formed and ready to be filled with concrete. The options for booster utility tunnels, service road, and pond have now been exercised, so that the entire booster enclosure is under contract, except for accelerator utilities. The building is scheduled for partial occupancy on February 26, 1970, and it should be completed by April 2, 1970.

Fig. 1. Linac-cavity tunnel, looking from the high-energy end.

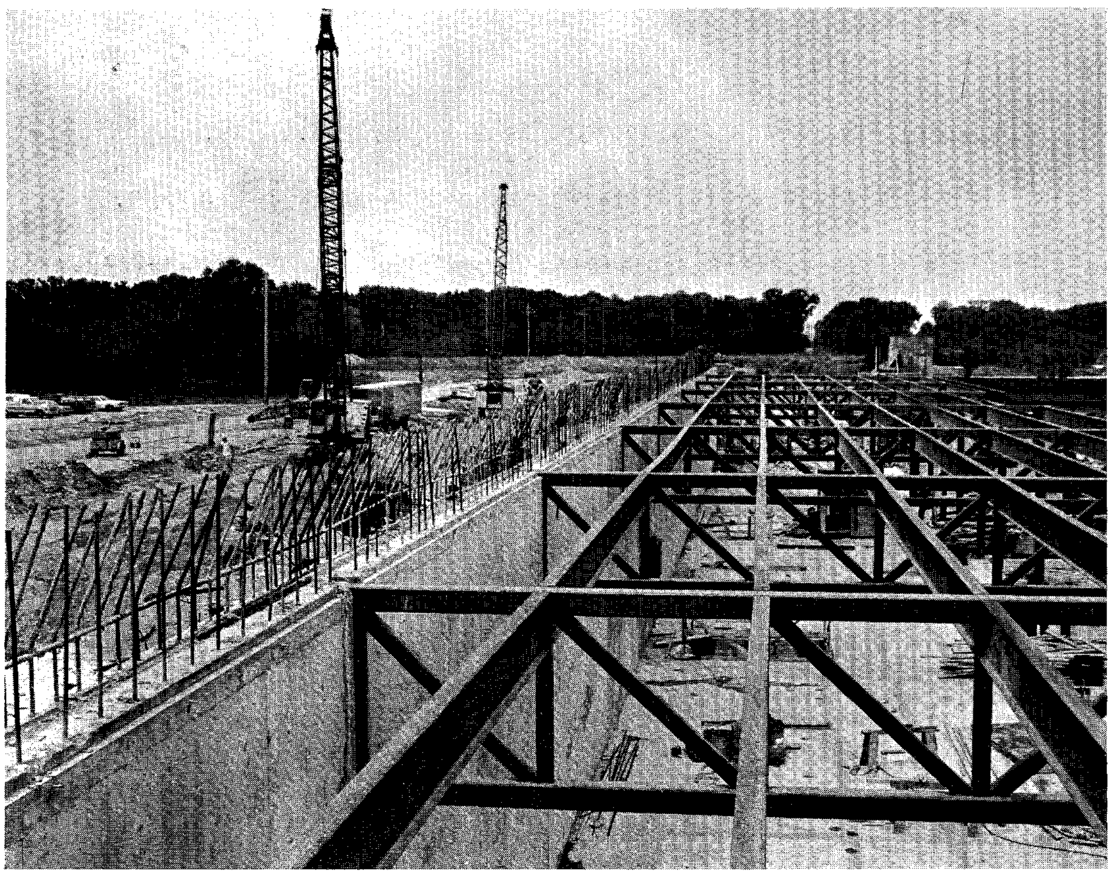


Fig. 2. Progress on the linac equipment gallery, from the high-energy end.

Fig. 3. The booster tunnel. This shows the sector closest to the main-ring site.

c. Cross Gallery. Work on this contract began in July and is now 5% complete. Figure 4 shows the excavation and forming work. This building phase is to be finished February 13, 1970.

d. Other Contracts. Figure 5 is a recent photograph of Road B, the second major road of the laboratory. This road has been built as part of the rough-roads and drainage contract, which is virtually complete.

Notices to proceed have been issued on rough roads in the industrial area and on the first water well.

4. DUSAF Move. On July 31, DUSAF moved all its architect-engineering operation from rented quarters in Hinsdale to the site. They are now occupying a number of buildings in the Village and some renovated farm buildings elsewhere on the site. Even the old Apostolic church has been converted for their use.

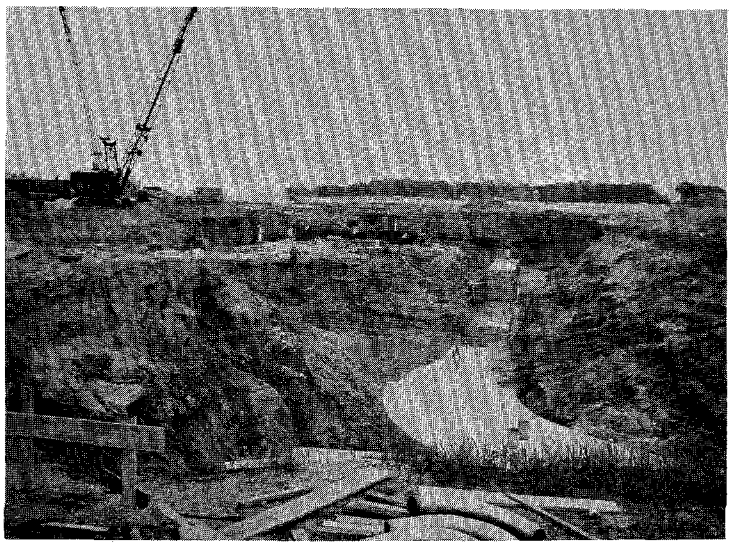


Fig. 4. Cross-gallery excavation and forming work. The roof of the vehicle access to the booster tunnel can be seen in the nearest part of the excavation. The view is from the linac toward the main ring and the booster is to the right.

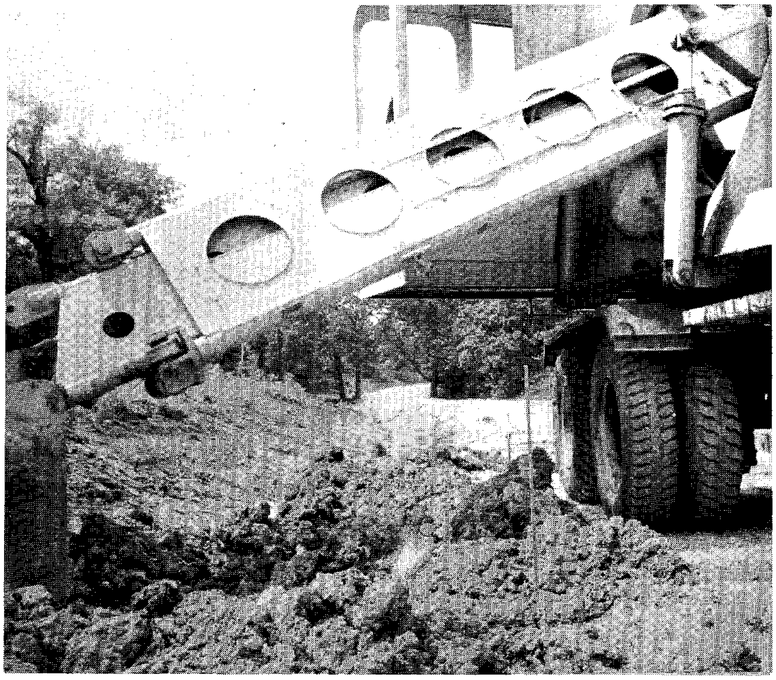


Fig. 5. Looking north on Road B.

Linac

1. <u>10-MeV Prototype.</u> The major effort in July has been to improve operation of the preaccelerator. The accelerator column was disassembled and cleaned. The outside surface of the column pressure vessel was also cleaned; it had become contaminated with soldering salts that gave rise to a low surface resistance, which also varied with ambient humidity. The high-voltage bleeder resistor along the column was found to be temperature-dependent and was replaced with a water resistor.

The result of all this work has been greatly improved operation. Figure 6 is an oscilloscope trace showing 10-MeV beam in the Faraday cup at the end of the linac (upper trace) and beam entering the linac (lower trace). The run shown has a peak current of 20 milliamperes into the linac and 5 milliamperes out, which is consistent with the phase acceptance of the linac. More than 6 milliamperes of 10-MeV beam has been observed and work is under way on emittance measurements and on further improvements. We are now confident that the 75 milliamperes of the Design Report will be achieved.

2. 200-MeV Linac Construction. Acceptance tests of the 800-kV high-voltage power supply have been completed at the fabricator's plant. The major tests were a full-load test, a long-term stability test, and a test of the regulation system under simulated beam loading. It is expected that the power supply will be delivered here in September.

Major procurements of technical components have been started with the new funds available in July. Commitments have been made for procurement of copper-clad steel plates for the 200-MeV cavities, copper for the drift tubes, drift-tube quadrupoles and their power supplies, the rf power-amplifier cavities, the modulated plate power supplies, a prototype filament power supply, and ceramic rings for a second preaccelerator column.

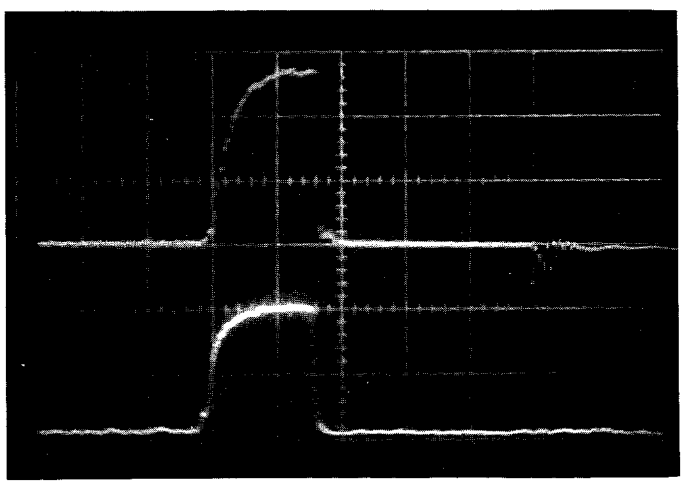


Fig. 6. Oscilloscope traces of linac beam. The lower trace is the signal on a beam toroid between the preaccelerator and the linac. The upper trace is beam on the Faraday cup at 10 MeV. Both horizontal scales are 20 microseconds/cm. The vertical scales are such that this run shows 20 milliamperes into the linac and 5 milliamperes accelerated.

Booster

1. Prototype Enclosure. Two full-scale magnets have been installed in the booster prototype enclosure on temporary supports, as shown in the cover photograph, and powered to full field at design frequency, 15 Hz. The power supplies were dc silicon-controlled rectifiers borrowed from Brookhaven National Laboratory. They were connected in the "series-pumping" mode, that is, in series with the magnets. This is a significant test of this new power-supply concept and we are pleased with the results.

2. Magnet Program. Both F and D carbide dies are completed and prototype quantities are being punched. A 3-foot F model has been stacked for magnetic measurements. Figure 7 is a plot of relative gradient of this magnet, compared with theoretical gradients of the ideal profile. Theoretical gradients derived from the real measured profile match the measured fields even more closely. The good agreement is particularly pleasing to us because an earlier F-magnet model had shown definite disagreement between theory and experiment, which was caused by errors in the lamination shape and in stacking.

Beam Transfer

1. 8-GeV Transfer. The design of the beam optics for the 8-GeV transfer system from booster to main ring has been carried out. Most of the transport elements will be shortened versions of main-ring B1 and quadrupole magnets. Redesign of the end connections in these shortened magnets has been completed. These changes will double the number of series coil paths to give operation at twice the voltage and half the current level. Design of special-configuration magnets for this transfer line is also under way.

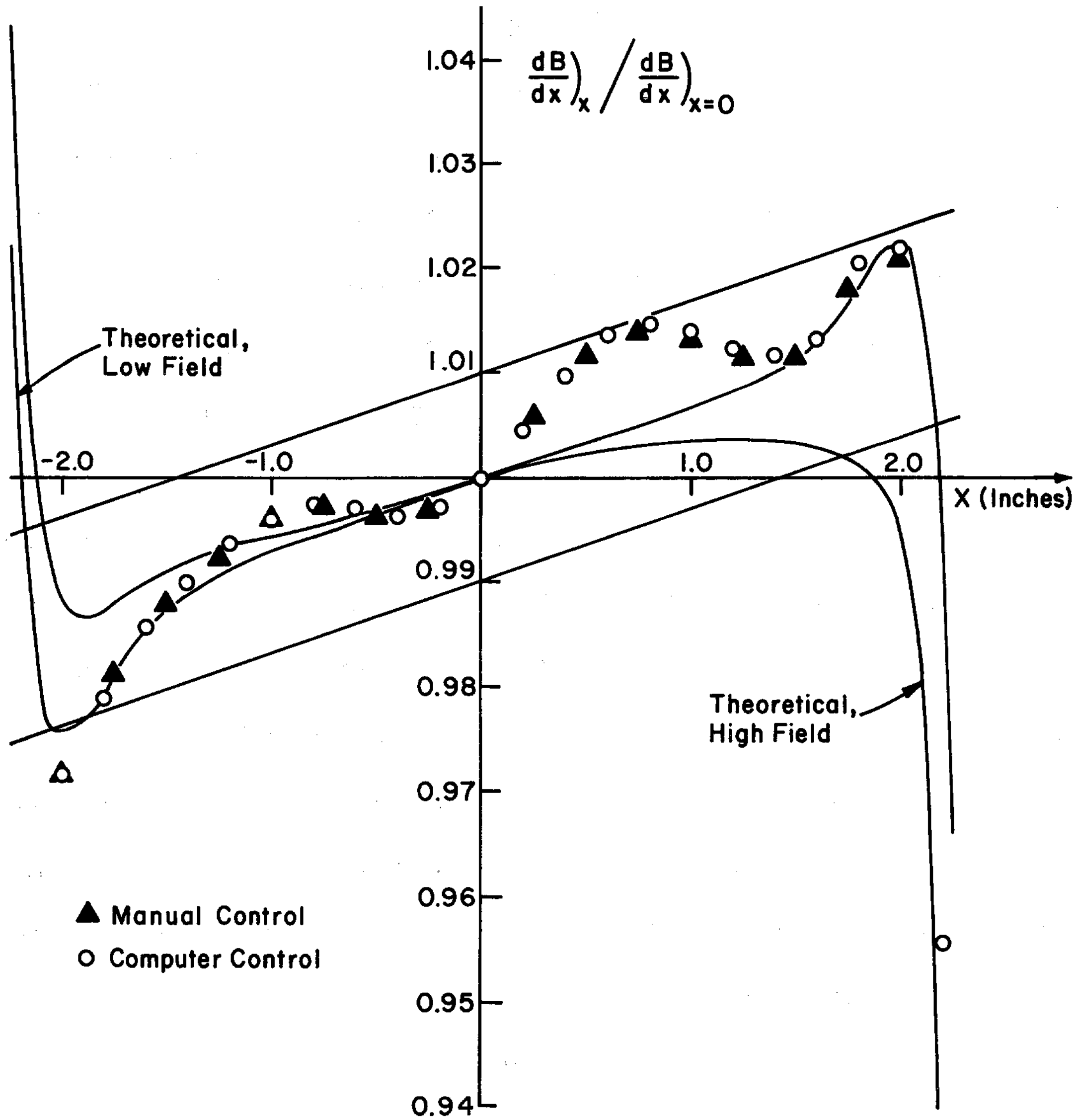


Fig. 7. Measured and computed relative field gradients of a booster F magnet. Measured gradients are taken at 5 kilogauss central field.

A prototype of the switch for the booster-extraction kicker magnet has been tested. It is shown in Fig. 8. The rise time of the output pulse, shown in Fig. 9, is 20 nanoseconds to 500 amperes, entirely adequate for booster extraction. The jitter in rise time is approximately 2 nanoseconds. The unit has now logged approximately 29 million pulses with no failures of major components. Work is also being done on a kicker magnet utilizing a built-up rectangular-bar ferrite core, which, if successful, could give substantial economies in kicker-magnet construction.

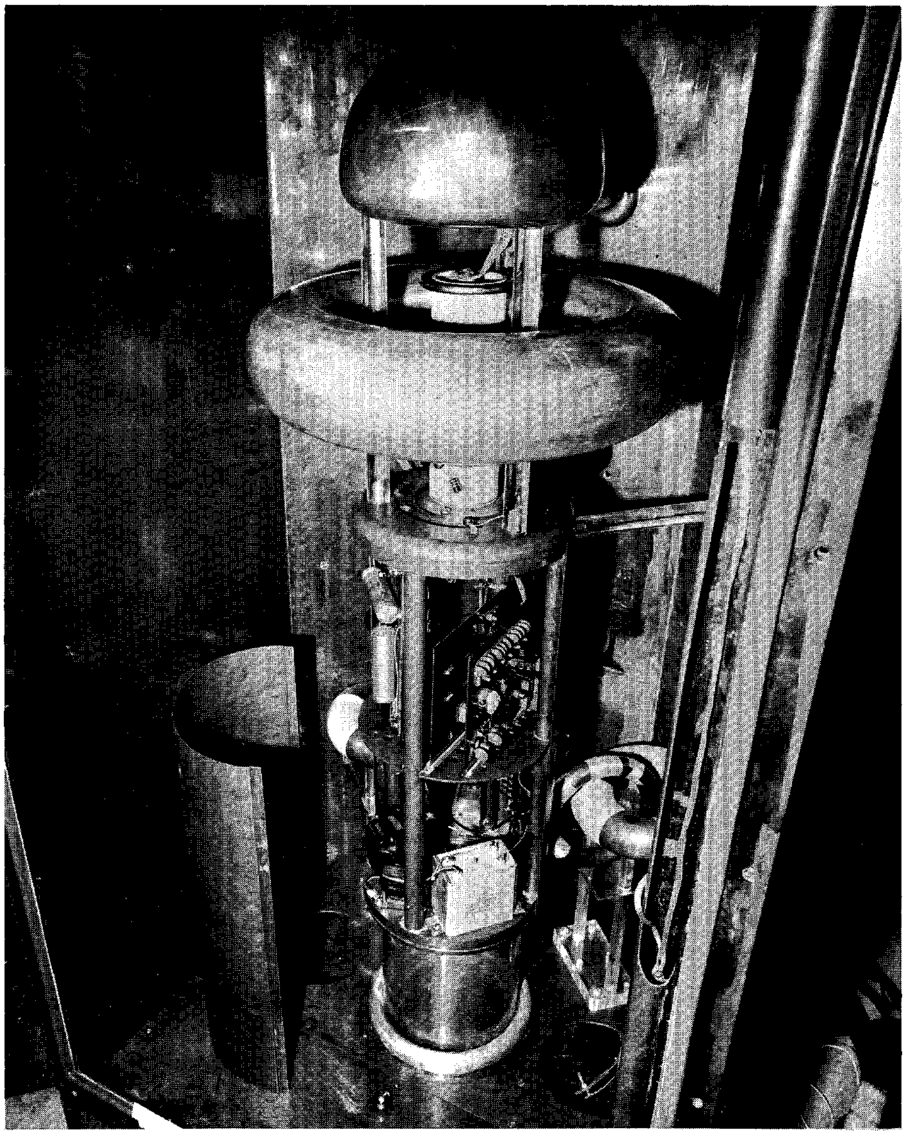


Fig. 8. Prototype switch for the booster-extraction kicker magnet.

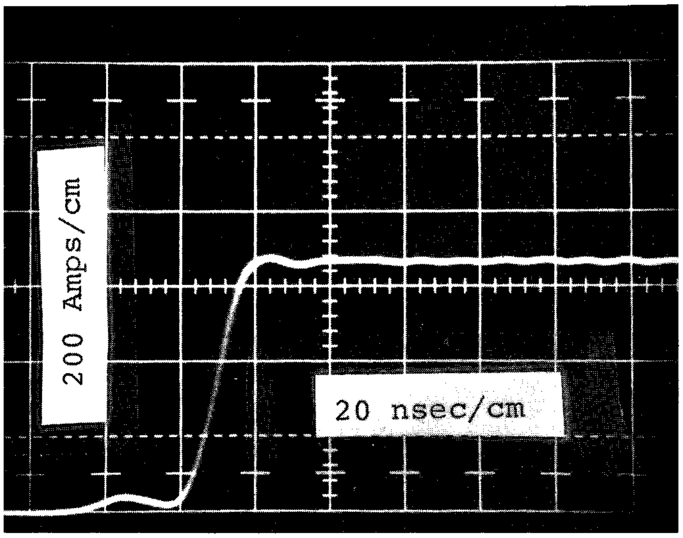


Fig. 9. Current rise time of the switch of Fig. 8.

Magnetic measurements have been carried out on a model of an eddy-current pulsed septum magnet shown in Fig. 10. This magnet is being considered for use in the booster-extraction system. It has a one-turn coil and a tape-wound core, an aperture of 1 square inch, and a septum thickness of 0.09 inches (2.2 mm). The field is 10 kilogauss. The measurements to date have shown that the field varies less than 2% across the aperture and that the leakage field outside the septum at the time of extraction can be kept as low as 2 gauss.

2. Other Topics. Experiments are continuing to test the feasibility of using a wire grid as the cathode, as well as the anode, of the electrostatic septum. If feasible, this wire cathode will reduce the mass, and therefore the build-up of radiation, in the septum area.

A laser system is being built to test magnet-alignment methods. The system will measure remotely the location of components, a feature that will be required in the target box and near septa.

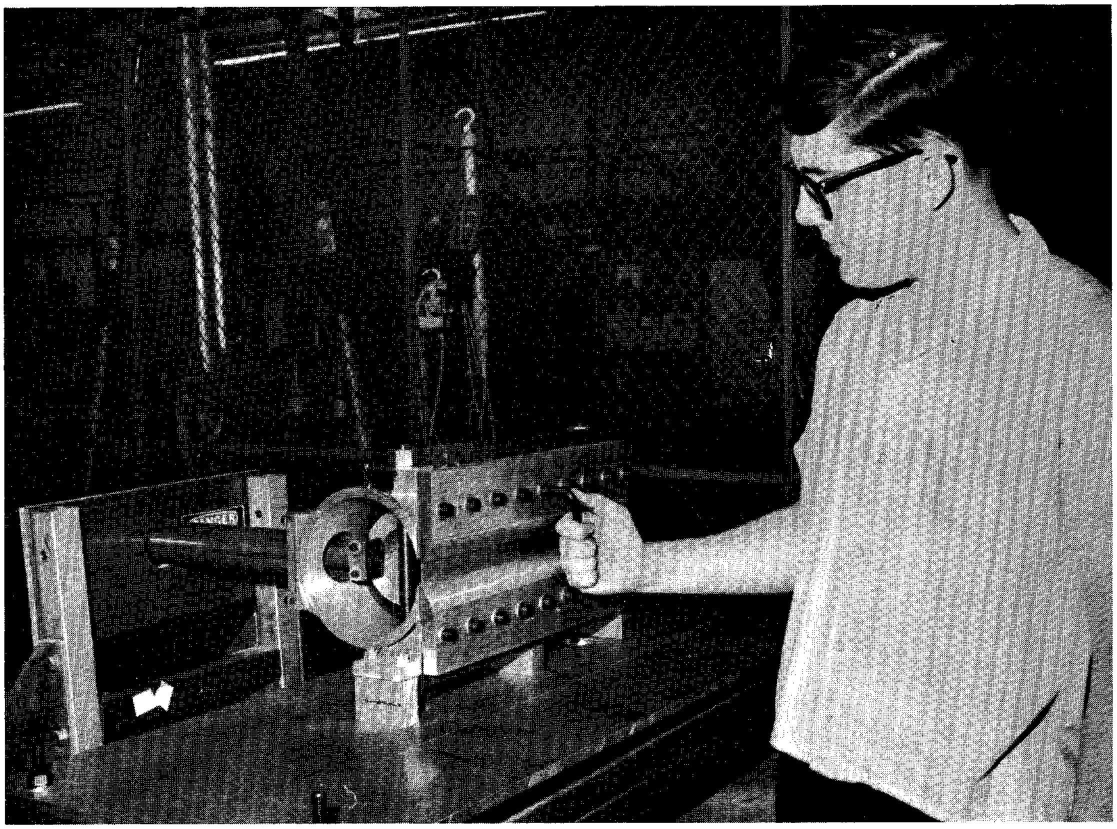


Fig. 10. Model of an eddy-current pulsed septum magnet. Ronald Cudzewicz is to the right.

Accelerator Theory

1. Secondary Beams. Members of the section participated in the Aspen Summer Study group that designed a set of secondary beams for Target-Station 2. The aim has been to find a "best" set of beams for the first experiments with sufficient flexibility that they would not need early reworking. Explicit designs have been worked out for a Y-shaped beam feeding side-by-side experimental areas, with beams at 2.5 and 7.5 milliradians, an rf-separated beam at 12 milliradians, a high-intensity π beam at 3.5 milliradians, and long-lived neutral beams. A detailed report will be included in the Summer Study Proceedings.

2. Computation. The Remote-Access Data-System (RADS) terminal linked to the Argonne IBM 360/75 is now in operation. The move of DUSAF to the site brings an IBM 1130, which has been installed in the Village. It will be used both as a terminal to the New York University CDC-6600 and as a utility computer.

Main Accelerator

1. Magnet Program. A 3-foot B2 magnet has been assembled and tested. The inner conductors of the coil were not located to the required accuracy; these errors are readily detectable by magnetic measurements. The measured and computed fields are in very good agreement as points where the coil is properly located.

Radiation Physics

1. Sealant Tests. Irradiation tests have been made of various sealants and water barriers for use in the main-ring enclosure. PVC (polyvinyl-chloride) water barrier and bituminous waterproofing performed satisfactorily after an absorbed dose of 10^8 rads (10^{10} erg/gram), whereas other materials became quite brittle and cracked. We have therefore recommended the use of PVC in the main-ring enclosure.

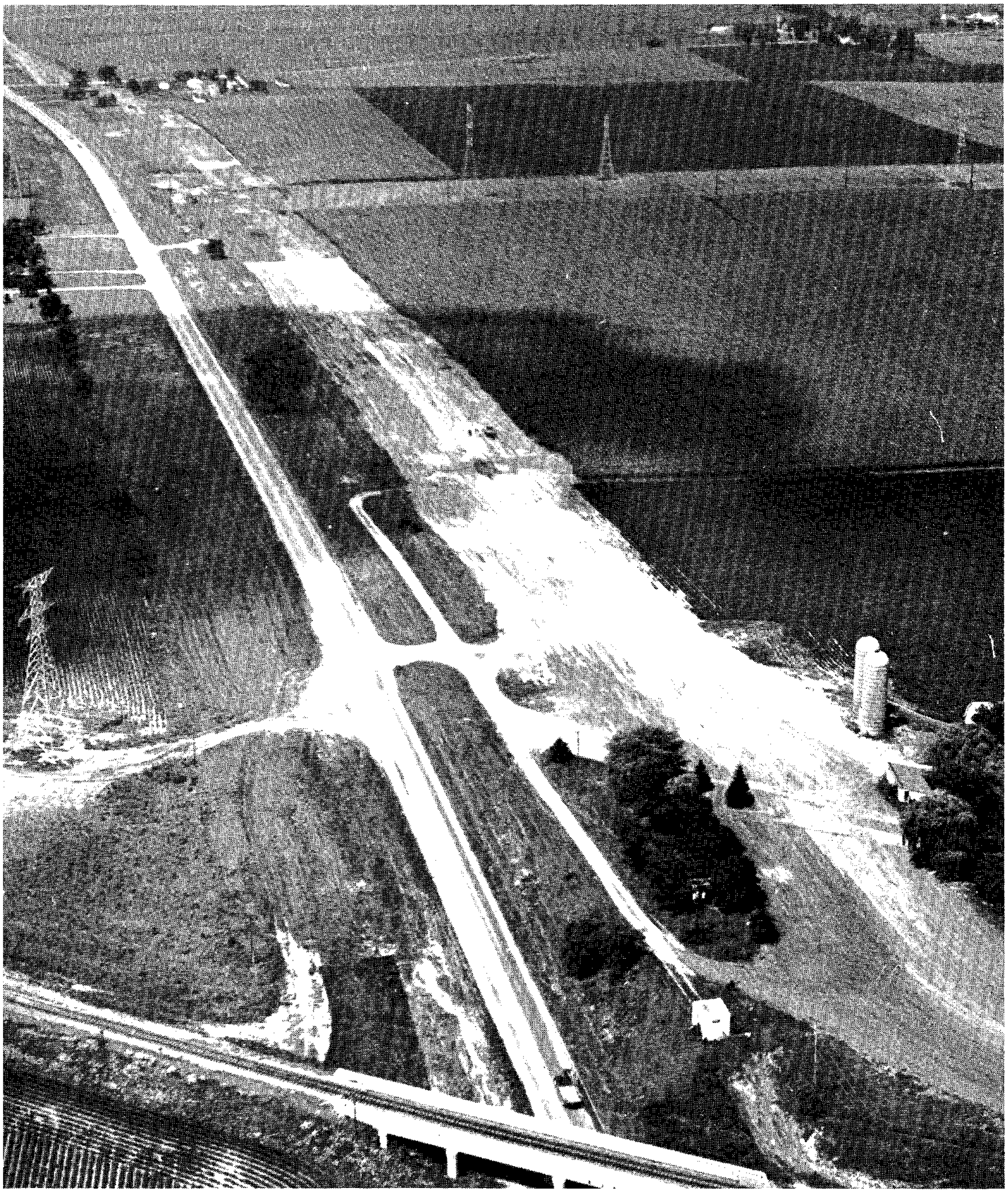


Fig. 11. Work on moving gas and electric lines to the site boundaries (this work is being carried out by the State of Illinois). The view looks west. Butterfield Road (Illinois Route 56), the southern site boundary, runs from top to bottom. The railroad tracks (Elgin, Joliet and Eastern R. R.) are the eastern site boundary. A new tower is at the lower left. The old power lines can be seen at the top. The new gas line, replacing one running across the main ring, has been installed in the cleared area just inside the site.